MOBILE LECTURE INTERACTION: MAKING TECHNOLOGY AND LEARNING CLICK

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ABSTRACT

We present the MLI (Mobile Lecture Interaction) application for enhancing lecture interaction between a teacher and the students. With their personal mobile phones students can anonymously ask questions and support questions from other students by voting for them. The questions and their support are displayed in real-time to the teacher who can then address them as (s)he finds appropriate. The results of the empirical evaluation of the MLI application in the real usage context at eight university lectures showed that the MLI improves the lecture interaction in a meaningful way.

KEYWORDS

Smart phone, Java, teacher, student.

1. INTRODUCTION

This study is motivated by the lack of interaction between an instructor and the students in the traditional lecture setting, and the detrimental effect this lack of interaction has on the learning motivation of the students. As a candidate solution for enhancing the lecture interaction in a meaningful and cost efficient way we present the novel Mobile Lecture Interaction (MLI) application. The MLI comprises of a student application for a standard personal mobile phone and a teacher application running on a PC. Using the mobile application a student can anonymously present questions and vote for questions made by other students. The teacher application presents the questions to the instructor. The instructor is alerted of popular questions, which have received votes from the designated minimum proportion of students. The instructor can then choose the questions (s)he wishes to answer in detail.

This paper is organized as follows. Section 2 discusses the shortcomings of lectures as a form of classroom instruction and how mobile technology has been previously used to enhance lecture interaction. Section 3 presents the design process behind MLI and Section 4 the technical implementation of the MLI using standardized off-the-shelf technology without any specialized hardware. Section 5 summarizes the main results of the empirical evaluation in a real-life setting, and Section 6 concludes the paper.

2. LECTURES AND MOBILE TECHNOLOGY

Lecturing is still the most widespread form of classroom instruction in higher education. In the traditional classroom, communication between the teacher and students is frequently unilateral from teacher to students and is seldom bilateral when teachers expect students to answer questions. In the famous learning pyramid lecture is shown to have the lowest retention rate (5%) of different teaching methods, compared to for example demonstration (30%) and practice by doing (70%). At least to a certain extent the low retention rate is explained by the generally low interaction between the instructor and the students. Lectures with a large audience provide a problematic since only one or at most a few students are able to interact with the lecturer at a given moment. The overwhelming majority will not profit from this form of interactivity. This in turn leads to students becoming passive in their learning. Additional problems arise if the lecturer wants to get feedback on how the lecture is accepted by the students, and what he or she can do to improve it. In lectures with a small audience the teacher can typically deduce this information from the students' reactions, e.g., looking bored. In large classrooms such information is usually gathered by handing out feedback questionnaires at the end of a lecture period. Unfortunately this approach is rather imprecise and does not allow the assessment of individual elements contained in a lecture. Furthermore, it is not possible for the lecturer to quickly react to problems.

Interactivity represents an opportunity for the learner to take hand in shaping the informational, communicational and learning process rather than remaining a passive recipient. Thus, an active involvement of the learners has a great impact upon successful learning (Krause and Effelsberg 2003). The only forms of interactivity in our universities are the questions that are asked spontaneously by the students. This is difficult in large lectures. First of all, not all students are able to ask questions because of time constraints. Secondly, many students do not dare to ask questions in front of a large audience because they are too shy or just because they think that their question is not good enough. If students can pose questions only at certain times, they will be out of context when finally speaking up. All these problems cause many students not to interact at all during the lecture. Finally, a fundamental problem in traditional lectures is the required continuous attention of the learner over 60 to 90 minutes. Usually, the attention span of a learner is only about 20 minutes. Only this period can be tolerated before the brain seeks other stimulation, either internal (e.g., daydreaming) or external ("Who is that walking down the hall?"). If the teacher is not providing any innovation, the brain will go elsewhere (Perry 2000).

Hence, no matter how good a teacher is, if he teaches solely by lecturing, he will lose the attention of many students just minutes after the lecture has begun. An interactive system such as a mobile device could maintain a much higher level of student involvement. In general, mobile devices can be considered as important devices that can be used to enhance learning and teaching environment. Students and staff enjoy using them and they seem to increase student motivation, and moreover they are important devices that can be used to enhance the learning and teaching environment. This has been assessed in many recent projects and studies focusing on the use of mobile devices in education. For example, mobile devices can be used for different purposes: communication with teacher and students (Lim and Lee 2002; Seppala and Alamaki 2003), taking a whole course as distance education (Giunta 2002; Roberts et al. 2003), reading and accessing course materials (Waycott 2002; Meisenberger and Nischelwitzer 2004), taking quizzes and exams (Homan and Wood 2003; Whattananarong 2004), playing learning games (Ketamo 2002), in field studies (Rieger and Gay 1997), using different activity programs in classroom (Tatar et al. 2003), managing lessons, tracking students' records, and online registration for courses. According to these studies, the use of mobile devices increases attendance to courses, collaboration between students, communication between teachers and students, study time for students by increasing the flexibility of time and location.

Attewell and Saville-Smith (2004) have stated that handheld computers assist students' motivation, help organizational skills, encourage a sense of responsibility, support both independent and collaborative learning, act as reference tools, track students' progress and deliver assessment. Milrad (2004) discussed the number of useful features that mobile technologies provide for education in terms of social interactivity, individuality, context sensitivity, connectivity and portability.

A number of applications and tools have been proposed for enhancing lecture interaction, including 'clickers' (e.g. H-ITT (2007), formally known as Personal Response Systems (Duncan 2005)), ClassTalk (2007), ConcertStudeo (Dawabi et al. 2003), Discourse, ClassInHands (2007) and Numina (Heath 2005). Some of them require specialized hardware, while some are applications for PDA's. None of them can be used with a regular mobile phone, which is one of the external requirements for our MLI application.

3. MLI – DESIGN

As the design method we employed Newman and Lamming's (1995) well-known interactive system design process. In the model so-called situation of concern, where everything is not quite right, gives rise to the design problem which is expressed in form of a problem statement. In our study the situation of concern is a lecture, which suffers from the lack of interaction between the teacher and the students, which in turn contributes to the poor retention rate of the lecture and loss of students' motivation, as discussed in Section 2. Our problem statement is the following: "Design an easy to use web/mobile application for teachers and students, to support their interaction during lectures". The problem statement identifies four fundamental issues in the design problem: human activity to be supported (interaction during lectures), users performing the activity (teachers and students), setting the level of support i.e. usability (easy to use) and basic form of solution (web/mobile application). The design problem is then addressed with an iterative/parallel execution of five processes: user study, activity modeling, specification, analysis of the design, and evaluation of the prototypes.

We implemented our user study as a combination of scenarios, interviews and a questionnaire. Scenarios (use cases) are concrete descriptions of usage situations, which are employed to guide the design (Carroll 1995). In this approach the designer focuses first on the human activities that need to be supported and then allows descriptions of those activities to drive the design. We employed imaginary scenarios for both a student and a teacher, which are omitted for brevity.

We conducted a survey to obtain a better understanding of the students' perception of their interaction behavior at lectures and how a mobile device could change that. We established an online questionnaire containing the previous scenarios and 14 questions. We advertised the survey by sending an email to the student email lists. Over 300 students visited the survey webpage, but only 56 students answered the questionnaire properly. Most of the respondents honestly acknowledged that they do not really interact at lectures. We observed high expectations on the impact the mobile application could have on the students' interaction activity.

We conducted free-form interviews of a number of professors at different faculties, probing their views on lecture interaction and how a tool such as the MLI could support teaching. The general consensus among the professors was that they wanted to have more interaction with the students at lectures. Most of them were willing to give the MLI a go, if they just were lecturing a course when we were going to conduct the experimental evaluation.

Analyzing the data from the user study we can model the users' current activities in form of task and process models. Given them, we can then synthesize a new improved activity model that would at least partially resolve the original situation of concern. The analysis of the models and synthesis of the new model generates the requirement specification of the system. The problem statement can be considered as the initial requirement specification. In the requirements specification process of an interactive system, the most essential activity is to define a usable functional form for the system. In other words, the four components of the initial problem statement – the users, activity to be supported, the level of support, and the form of solution – need to be expanded into an adequate specification of the system's functionality and usability. Given the data of the user study, we identified the actions for a student and for a teacher. In terms of implementation, the requirements were phased into two versions, and this study concerns the first version.

4. MLI – IMPLEMENTATION

The MLI was implemented using the traditional client-server architecture. The MLI comprises of four components: teacher application, student application, a server and a database. The database stores course information, the questions presented by students and the votes cast by students. The server application coordinates the communication of the student and teacher applications with the database over the public Internet.

The most important external requirement was that the MLI application should be as much technology independent (i.e. portable) as possible. Further, the teacher application should run on a PC, and the student application should run on a personal mobile phone, without any additional special hardware. This effectively implied Java implementation, as all widely-used operating systems for PCs and most modern mobile phones support Java. The only more general implementation would have been a web application used with web browsers. However, it would not have provided the desired real-time communication between the student and teacher applications. Further, a separate client application on the mobile phone provides much better usability than their browsers.

The server was implemented as a multi-threaded process using Java. The server process establishes separate execution thread for each student application and the teacher application, to guarantee timely real-time communication with each client process. The actual data transfer took place over TCP (Transmission Control Protocol), which provides flow and error control. The database was implemented using MySQL.

The student application was implemented as a Java MIDlet using J2ME (Java 2 Platform Micro Edition) MIDP (Mobile Information Device Profile) intended for resource-constrained devices such as mobile phones. Figure 1 shows sample screenshots of the user interface of the student application. The UI conventions follow that of the S60 platform which is the leading smart phone platform in the world.

The teacher application was implemented as a dynamic webpage using PHP (PHP: Hypertext Preprocessor). Figure 2 shows a sample screenshot of the user interface of the teacher application. The main window shows the running ID number, the subject, the detailed description and the percentage of students having voted for that particular question for each question submitted by the students. If the percentage of students having voted for a particular question exceeded the threshold set by the teacher, then a popup alert was generated to draw the teacher's attention to this particular question.

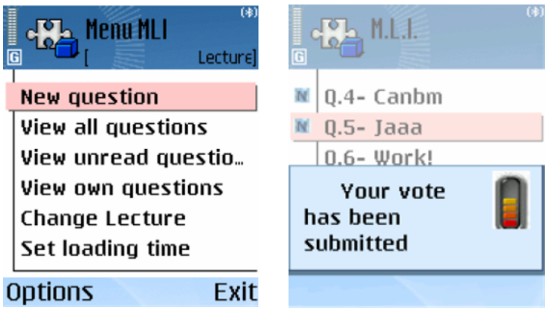

Figure 1. UI screenshots of the student application.

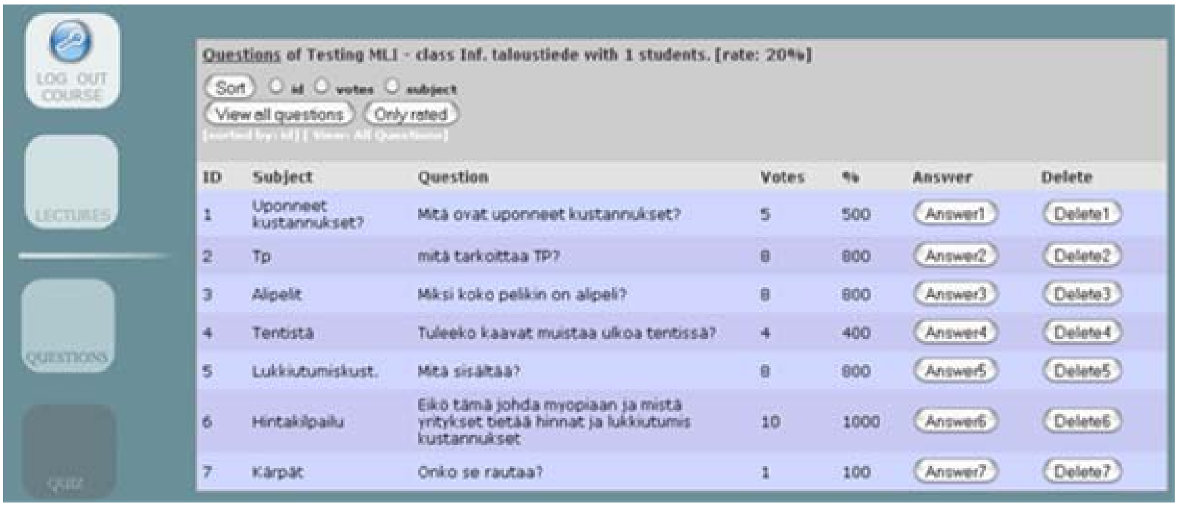

Figure 2. An UI screenshot of the teacher application.

5. MLI – EMPIRICAL EVALUATION ON REAL LECTURES

To evaluate MLI in the real context of usage, it was tested on eight real lectures in a multidisciplinary university. The eight lectures are listed in chronological order in Table 1, showing the topic of the lecture and basic usage statistics on each lecture. To obtain access to these lectures, we approached teachers providing ongoing courses particularly in nontechnical faculties. Lecture #6 took place at the faculty of education, lectures #1 and #7 at the faculty of science, and remaining five lectures at the faculty of economics and business administration.

Each lecture was two hours in duration. At the beginning of a lecture 15 minutes was used for introducing the MLI, and for distributing the mobile phones and questionnaires to the students. The phones were Nokia smartphones (Nokia 6670, Nokia 6630 and Nokia 7610) and the mobile phone network for the data connection. The students did not have to pay for the data connection. The MLI application was installed on each phone beforehand.

The questionnaires were collected at the end of the lecture. As the comparison of columns 'Used' and 'Survey' in Table 1 shows, not all students using the MLI application during the lecture did return a properly filled questionnaire. The column 'Alert' reports the number of questions creating a popup alert in the teacher application after getting votes from the designated minimum proportion of the students currently using the

MLI (typically set to 30%). Lecture #0 served as the final technical dress rehearsal of the system, and no questionnaire was presented to the students. Pair wise comparison of lectures #0↔ #4 and #3↔#5 shows how in the second lecture with the MLI the students were much more confident to use the application, leading to larger numbers of questions and votes per student.

Table 1. Basic information of the lectures where MLI was tested

#	Topic	Students		Questions		Votes		
		Used	Survey	Total	Alert	Total	Per student	Per question
0	Economic of network industries	34	-	6	0	44	1.3	7.3
1	Principles of programming languages	6	5	3	3	12	2.0	4.0
2	Marketing research and information systems	33	28	17	10	182	5.5	10.7
3	Consumer behavior	34	32	15	4	126	3.7	8.4
4	Economics of network industries	33	28	7	7	120	4.3	17.1
5	Consumer behavior	31	27	14	10	180	6.7	12.9
6	Applications of Psychology	35	35	18	14	178	5.1	9.9
7	Internet and information networks	12	11	4	4	35	2.9	8.8

The questionnaire filled in by the students contained, among other things, a number of statements to which the respondent was asked to answer on 5-point Likert scale (1=disagree completely … 5=agree completely). For brevity we present the average values for selected nine statements over all 166 respondents: "Using MLI made the lecture more interesting" (3.40); "I liked/enjoyed using MLI" (3.95); "The fact that MLI gave me anonymity encouraged me to use it" (4.03); "With the help of MLI, I would ask questions I would not ask orally" (3.95); "MLI disturbed the following of the lecture" (3.27); "The lecture might be better without MLI" (2.66); "MLI supports my learning" (3.35); "MLI is a better way to interact with the lecturer than the traditional way" (2.77); "I would want to use MLI again in the future" (3.80). We can conclude that the students enjoyed using the MLI and it made the lectures more interesting. The students certainly appreciated the opportunity to ask questions anonymously. Still, many students were doubtful whether this kind of an application is a better way to interact with the lecturer than the 'traditional' way.

6. DISCUSSION

We presented the first version of the MLI application for enhancing the lecture interaction between a teacher and the students. The design of the MLI is based on extensive user study carried out in form of scenarios, interviews, and an online student questionnaire. With the student application a student can anonymously ask questions and vote for the questions asked by other students. The teacher application displays the questions and their support among students to the instructor, and alerts the instructor of questions that enjoy sufficient support among students. The MLI was empirically evaluated in the real usage context on eight lectures.

The implementation of the MLI generalizes very well, as the MLI comprises of standard off-the-shelf components communicating over the public Internet. The student application runs on a standard personal mobile phone, which is beneficial for many reasons. First, the university does not have to invest in separate devices, which also need to be serviced and stored. Second, a student is familiar with his/her personal mobile phone, which makes adoption of new applications easier.

One apparent shortcoming of our study is that the students did not have to pay anything for the mobile data service, which in some studies has been identified as one hindrance for this type of applications (). However, this problem is disappearing for two reasons. First, mobile phones are increasingly equipped with WLAN (Wireless Local Area Network) radios and most universities have campus WLAN networks providing free Internet access to students. Second, most operators are increasingly bundling ample mobile data service into their regular subscriptions. For cost reasons we did not even consider a SMS (Short Message Service) based implementation, which also would not have been able to provide the timely communication needed in the real-time interaction between the teacher and the students.

In the future we will implement an advanced version including quizzes and the PC student application, and deploy the MLI in a larger scale. One very promising use case is distance education, where lectures given on the main campus are transmitted as real-time video feed to satellite campuses, where students have poor return channel to interact with the teacher.

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